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ABSTRACT

A model was developed to provide a uniform method for vocational and technical education content experts to develop test items (written questions and performance measures) that are congruous with course-level exit competencies. The model is essentially a closed-system approach in that specific action verbs must be identified and operationally defined. Once identified and defined, these action verbs are exclusively used when developing course-level competencies. The operational definitions of the action verbs include (1) general type of learning to be measured, (2) level of learning to be measured, (3) brief description specifying the nature of the learning, and (4) primary test item format that must be used to measure the learning. The test item writer is provided specific guidelines to follow when analyzing competencies and developing test items to measure these competencies. (Appendix A is the procedural guide for developing test items and performance measures. Contents include assessment requirements of a competency; advantages and limitations of types of test items; guidelines for writing each type of test item; and guidelines for developing performance assessments. Appendix B is a glossary of operational definitions of action verbs. Appendix C provides sample stems of multiple-choice test items related to specific action verbs.) (YLB)

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AUGUSTA AREA TECHNICAL SCHOOL

CURRICULUM AND

ASSESSMENT MODEL

REFERENCE GUIDE

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ABSTRACT

A model has been developed to provide a uniform method for vocational and technical education content experts to develop test items (written questions and performance measures) that are congruous with course level exit competencies. The model is essentially a closed-system approach in that specific action verbs must be identified and operationally defined. Once identified and defined, these action verbs must be used exclusively when developing course level competencies. The operational definitions of the action verbs include the following:

1. The general type of learning to be measured (intellectual skills, attitudinal skills, or psychomotor skills).

2. The level of learning to be measured (information level, application level, or problem solving level).

3. A brief description specifying the nature of the learning to be measured.

4. The primary test item format which must be used to measure the learning.

The test item writer is provided specific guidelines to follow when analyzing competencies and developing test items to measure these competencies. These guidelines specify not only the test item format but also the general type of learning and the level of learning to be measured.

Test items are coded to the competency which they are intended to measure, to the type of learning which they are intended to measure (intellectual, attitudinal, or psychomotor), and to the level of learning which they are intended to measure (information, application, or problem solving). Multiple choice test items are loaded into a microcomputer software program which is designed to operate on the TANDY 2000 HD and the IBM PCXT computers. The software program is capable of generating random or stratified random tests. The testbank software is a combination of a locally developed package and a commercially developed data base manager (FilePro 16, Small Computer Company).

A test item analysis and test analysis software package has also been developed locally. This package is designed to accept data from a model 2100 Scantron optical reader and generate the following analyses:

1. A test item analysis yielding a matrix which compares item difficulty with student scores on the test.

2. A competency-by-students analysis yielding a histogram display of students' correct responses within each course competency and across all course competencies.

AUGUSTA AREA TECHNICAL SCHOOL

STUDENT ACHIEVEMENT

TESTING MODEL

Augusta Tech recognizes the multiplicity of purpose that tests play in the educational process. Tests function as teaching tools, as student assessment tools, and/or as instructional evaluation tools.

In order to fully utilize the potential of tests to promote educational quality, Augusta Tech has developed and implemented an operational testing model. The model provides a means of developing competency-referenced test item banks which are stored on microcomputers that, in turn, randomly generate final exams for courses taught at Augusta Tech. These exams not only reflect the content of what is intended to be learned but also the level of learning that is intended to be accomplished.

The model further provides guidelines for developing formative written tests and performance assessments (see Reference Guide, June 1986) thus supporting a variety of assessment techniques, which are used throughout the sequence of a course. Course level test banks are developed at the department or program level, involving all faculty qualified to teach the course, instructional supervisory personnel, and curriculum/assessment specialists.

Test data are analyzed to insure that students' grades reflect not only their level of attainment (including both achievement and ability) but also insure that instructional systems uniformly and consistantly deliver course exit competencies to all students enrolled in programs. Feedback from test data provides information which can be used by faculty and instructional supervisory personnel to improve instruction. Whenever standardized tests such as licensure, certification, or professional affiliation tests external to the institution are available and appropriate, they are used to verify the validity and the reliability of the institutional level tests, and the quality of the educational delivery system.

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INTRODUCTION

The curriculum, instruction, and assessment at Augusta Area Technical School is developed within the framework of an operational learning/assessment model which has been condensed from existing models in the educational arena (Bloom, 1956; Hively, 1974; Gagne and Briggs, 1979; Burry, Herman and Baker, 1984). The dynamic features of this model can best be described as containing both hierarchical and interactive characteristics (see Fig. 1). Roman numerals (I, II, III) represent three hierachical levels of learning/assessment in the model:

I. Information Level
II. Application Level
III. Problem Solving Level

The letters (A,B,C) represent the three interactive skill areas of learning/assessment within the hierarchical levels of the model:

A. Intellectual Skill
B. Attitudinal Skill
C. Psychomotor Skill

Intellectual skills are considered to play significant measurable roles at each of the three learning/assessment levels while attitudinal skills and psychomotor skills, although actively involved at all three levels, are considered to play significant measurable roles at the application and problem solving levels only. Therefore, attitudinal skills and psychomotor skills are excluded from level I of the model. Furthermore, it is believed that intellectual skills within the application level (II) can be further separated into two sub-groups (1,2).

The vertical arrows in the graphic description of the learning/assessment model (Fig. 1) are illustrative of the hierarchical nature between the levels of the model (I, II, III) with each level forming a substratum for the next higher level. The horizontal arrows illustrate the interactive nature of the skill areas (A, B, C) within the levels of the model. Since many learning/assessment activities involve the interaction of intellectual skills, attitudinal skills, and psychomotor skills, the model reflects the interactive relationships of the skill areas. Narrative descriptions of the learning/assessment levels and skill areas are provided in Figure 2.

In order to make the model fully operational, action verbs are identified, defined, and assigned to each of the skill areas within the levels of the model (see Fig. 3). These action verbs must be used when writing and/or refining competency and subcompetency statements for all curriculums. The selection and assignment of action verbs is a vital and a complex process. The following critical criteria must be considered when selecting action verbs:

1. The verbs must be action oriented in order to facilitate the learning/assessment process.

2. The verbs must be generic (not occupationally specific) so that they can be utilized across both occupational and academic content areas.

3. The verbs must be operationally defined so that they clearly distinguish between and within levels.

INTERACTIVE LEARNING/ASSESSMENT HIERARCHY

I. INFORMATION LEVEL

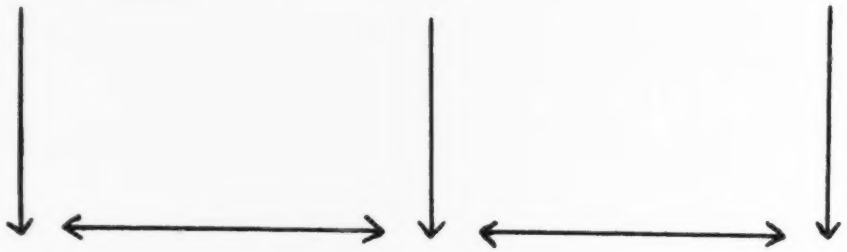
A. Intellectual Skills

II. APPLICATION LEVEL

A. Intellectual Skills B. Attitudinal Skills C. Psychomotor Skills

1

2



III. PROBLEM SOLVING LEVEL

A. Intellectual Skills B. Attitudinal Skills C. Psychomotor Skills

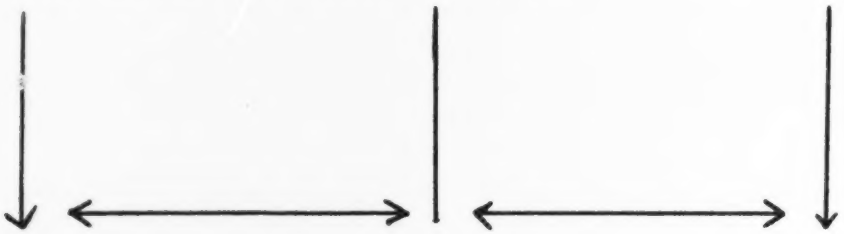


Figure 1

DESCRIPTION OF LEARNING/ASSESSMENT LEVELS and SKILL AREAS

I. INFORMATION

The primary activity at this level is the retrieval and organization of information either from memory and/or from available resources for the purpose of developing intellectual skills.

II. APPLICATION

The primary activities at this level are:

A. The use of intellectual skills to:

1. Apply information to learn concepts, rules, principles, procedures, processes, etc.

2. Apply procedures, rules, principles, and processes to determine (calculate) answers to problems.

B. Demonstrations of attitudes related to the application of procedures/techniques; e.g., process oriented.

C. Demonstrations of psychomotor activities related to the application of procedures/techniques; e.g., process oriented.

III. PROBLEM SOLVING

The primary activities at this level are:

A. The use of intellectual skills and cognitive stratagies to generate and/or originate solutions to real problems.

B. Demonstrations of attitudes related to the quality of job performance skills; e.g., process and/or product oriented.

C. Demonstrations of psychomotor activities related to the quality of job performance; e.g., process and/or product oriented.

Figure 2

LEARNING /ASSESSMENT VERBS FOR COMPETENCY/SUBCOMPETENCY STATEMENTS

I. INFORMATION LEVEL

A. Intellectual skills

LIST CITE
STATE/NAME
LOCATE
IDENTIFY/SELECT
ARRANGE/SORT

II. APPLICATION LEVEL

A. Intellectual Skills	B. Attitudinal Skills	C. Psychomotor Skills
1. CLASSIFY		
DEFINE		
RELATE		
EXPLAIN/DESCRIBE		
COMPARE/CONTRAST		
2. SOLVE	FOLLOW	MANIPULATE
CALCULATE		PREPARE
CONVERT		ALIGN/CALIBRATE
RECORD		INSTALL/ASSEMBLE
TRANSLATE/TRANSCRIBE		

DE ERMINE
INSPECT
INTERPRET
IMPLEMENT

MEASURE
PERFORM

III. PROBLEM-SOLVING LEVEL

A. Intellectual Skills	B. Attitudinal Skills	C. Psychomotor Skills
DEVELOP	INITIATE	SERVICE
ANALYZE	OPT/CHOOSE	REPAIR
MANAGE	EXEMPLIFY/EMULATE	CONSTRUCT/FABRICATE
DIAGNOSE/TROUBLESHOOT		

DESIGN
ASSESS
MODIFY

OPERATE

Figure 3

The exclusive use of the action verbs within the model to develop and/or refine course competencies and subcompetencies is necessary to promote curricular uniformity throughout all programs (see Fig. 4 for competency/subcompetency descriptions). Each action verb used in a competency/subcompetency statement corresponds to a specific skill area (A, B, C) within one of the learning/assessment levels (I, II, III). Furthermore, the operational definitions clarify the nature of the action verbs thus inhancing the uniformity of the learning/assessment process and maximizing the congruence between the competency/subcompetency statements and their corresponding assessment instruments. Operational definitions of the action verbs must include:

1. A skill area descriptor; e.g., intellectual skill, attitudinal skill, or psychomotor skill.
2. A learning/assessment level descriptor; e.g., information level, application level, or problem solving level.
3. An action verb descriptor; e.g., additional clarification of the nature of the action.
4. An assessment mode descriptor; e.g., specification of the primary manner that the student should be assessed.

Two examples of operational definitions of action verbs are:

Follow - An attitudinal skill where the student must function at the application level by following a set of procedures which must be primarily evaluated by direct observation of the procedures being followed.

Calculate - An intellectual skill where the student must function at the application level by finding an unknown value using rule(s) of mathematics which must be primarily evaluated by the accuracy of the calculation.

Appendix B contains a complete glossary of all action verbs in the model.

DESCRIPTIONS FOR LEARNING/ASSESSMENT MODEL COMPONENTS

Competency - Competencies are simple statements of what the individual will be capable of doing after completing a particular course and/or program of study. Competencies should be written in terms of optimum capabilities as opposed to minimum capabilities.

1. A competency may be intellectual, attitudinal, or psychomotor or any combination of these skills, but it must be primarily one of these skills.

2. A competency statement begins with an action verb and must be followed by an object.

3. A competency is made up of a minimum of two (2) subcompetencies.

4. A competency can be objectively measured by measuring its corresponding subcompetencies.

Sub-Competency - Subcompetencies are all of the logical components (operations) which make up a competency e.g. the sum total of the competency.

1. A subcompetency may be intellectual, attitudinal, or psychomotor or any combination of these skills, but it must be primarily one of these skills.

2. A subcompetency is a statement beginning with an action verb and must be followed by an object.

3. A subcompetency must be written at the same level or slightly below the level of the competency.

4. A subcompetency will be measured objectively.

Figure 4

(Page 7 continued)

Departmental Test - A stratified-random computer generated test based on all competencies/subcompetencies for a given course of study. The departmental final exam may also include a laboratory performance evaluation.

Curriculum/Assessment

Instruction

Performance Objective - Performance objectives are all of the logical steps (knowledge, skills, and attitudes) necessary for the learning of subcompetencies.

Figure 4 (Cont.)

As has been stated, the operational definitions of the action verbs specify the primary means of evaluating students e.g. the test item format to be used to measure student achievement and ability. However, it should also be noted that there are indirect assessments which may be used to verify (but not replace) the more direct (primary) assessments of student achievement and ability which occur throughout the entire instructional process. For example, the primary manner of evaluating a student following a given set of procedures is the direct teacher observation of the student following those procedures in actual situations; e.g., a performance evaluation. However, by presenting written situations to the student (an interpretive situational exercise), the student could be asked objective questions regarding his/her knowledge and understanding of specified procedures, and his/her probable actions; e.g., a written evaluation.

The essential objective of this indirect situational questioning is to ascertain how much the student understands about what (s)he is doing with the premise that those students having done well in the performance assessments will also do well on the written assessments. This and other types of indirect assessments, if truly representative of the primary assessments, can serve to verify the primary assessments that are specified in the program competencies/subcompetencies. Due to the nature of the model, and to its practical and economical application in the school setting, indirect assessments of competencies/subcompetencies play an major role in an overall integrated assessment process.

Assessment of course competencies/subcompetencies is being accomplished at Augusta Area Technical School using a departmentalized testing framework. Presently, departmental testing occurs primarily during the final examination phase of the learning/assessment process. These examinations must include a representative sample of written test items from a comprehensive test item bank which measure all course competencies/subcompetencies, but, when appropriate, will also include performance evaluations. Final examination test item banks are developed by teachers within departments and reviewed by peer teachers. Final examinations are generated by microcomputers and are then administered by proctors who follow explicit written instructions.

Accomplishments of Augusta Area Technical School include:

1. Competency-based computer test banks with test items and performance measures keyed to course competencies/subcompetencies.
2. A stratified-random test generation process which generates departmental tests based on course competencies/subcompetencies.
3. An automated test scoring and test analysis process which generates analyses regarding individual and group performance specific to each competency/subcompetency and across all course competencies/subcompetencies.

In order to facilitate uniformity in the development of written test items and performance measures, Augusta Area Technical School has developed a procedural and production guide (see Appendixes A and B). The guide offers general procedures for writing test items and performance measures.

APPENDIX A

GUIDELINES FOR

DEVELOPING TEST ITEMS

AND PERFORMANCE MEASURES

Assessment Requirements of a Competency/Subcompetency

The primary assessment requirements of a competency/subcompetency are the rules that must be observed in the development of assessments if the actions called for by competency/subcompetency statements are to be measured validly and reliably. The major assessment requirements are described below.

1. The assessment of a competency is accomplished through the assessment of its corresponding subcompetencies. A competency may have subcompetencies that involve intellectual skills, attitudinal skills, and psychomotor skills or any combination of these skill areas.

2. The primary assessment of each subcompetency (written test item, or performance evaluation) must directly correspond to the skill area specified in the subcompetency. A subcompetency will require the student to demonstrate achievement and ability with primary emphasis in one of the following skill areas:

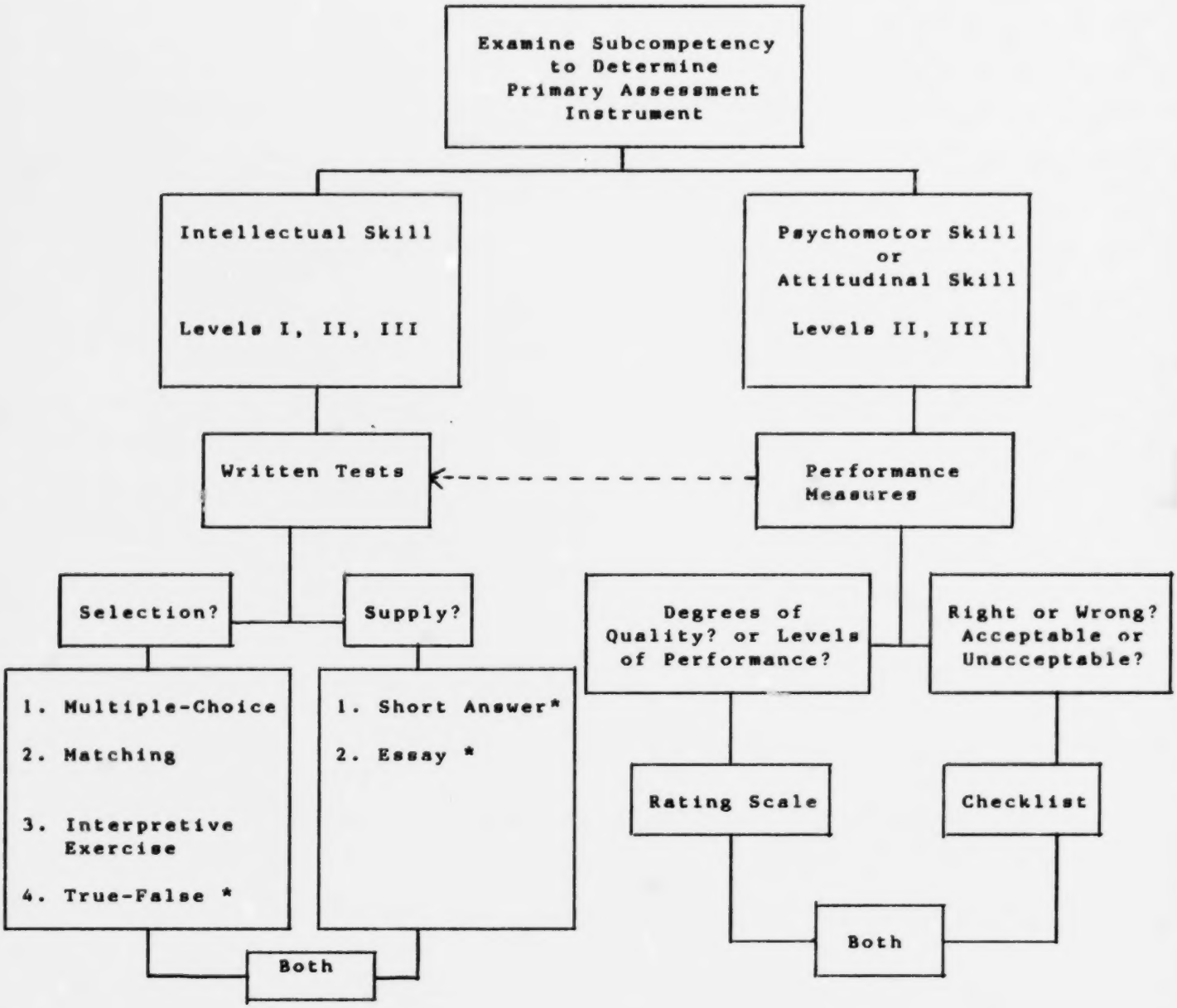
   a. Intellectual skills
   b. Psychomotor skills
   c. Attitudinal skills

3. The assessment of a subcompetency (written test item, performance evaluation) must directly correspond to the level of learning specified by the subcompetency. A subcompetency will require the student to demonstrate achievement and ability at one of the following levels:

   a. Information Level
   b. Application Level
   c. Problem Solving Level

4. Because of the interactive nature of skill areas, the assessment of a subcompetency will also involve indirect measures of student achievement and ability. For example, a subcompetency which has been identified as being primarily psychomotor will be required to have test items that indirectly measure those intellectual and/or attitudinal skills that interact with the primary psychomotor skill being measured.

Figure 1
Determining the Appropriate Type of Assessment to Use



*Not addressed in this guide.

ADVANTAGES AND LIMITATIONS OF SELECTION AND SUPPLY TYPE ITEMS

TYPE ITEM	ADVANTAGES	LIMITATIONS
MULTIPLE-CHOICE	1. SUBJECTIVE SCORING IS ELIMINATED. 2. GUESSING IS REDUCED. 3. VERSATILE ITEMS THAT CAN MEASURE FROM THE INFORMATION LEVEL THROUGH THE PROBLEM SOLVING LEVEL.	1. GOOD ITEMS ARE DIFFICULT TO WRITE. 2. GOOD OPTIONS ARE OFTEN HARD TO FIND. 3. LONGER RESPONSE TIME BY STUDENTS DETERMINED BY LEVEL OF DIFFICULTY.
TRUE-FALSE	1. SUBJECTIVE SCORING IS ELIMINATED. 2. CAN COVER BROAD CONTENT IN SHORT TIME. 3. JUDGING TRUTH OF STATEMENTS SIMILAR TO REAL LIFE.	1. UNAMBIGUOUS ITEMS HARD TO WRITE. 2. GUESSING ENCOURAGED. 3. LIMITED TO RECALL, GENERALLY. 4. OFTEN MISUSED TO TEST TRIVIA. 5. OFTEN REINFORCES NEGATIVES.
MATCHING	1. SUBJECTIVE SCORING IS ELIMINATED. 2. CAN COVER BROAD CONTENT IN SHORT TIME. 3. CAN MATCH WORDS WITH DEFINITIONS, EVENTS WITH PLACES, CONCEPTS WITH WORDS, SYMBOLS, ETC.	1. SOMETIMES DIFFICULT TO DEVELOP, PARTICULARLY WHEN MEASURING HIGHER LEVELS. 2. MUST RELY ON HOMOGENEOUS MATERIAL.

(Page 14 continue)

ADVANTAGES AND LIMITATIONS OF SELECTION AND SUPPLY TYPE ITEMS

TYPE ITEM	ADVANTAGES	LIMITATIONS
SHORT-ANSWER	1. VERY EASY TO DEVELOP ITEMS. 2. GREATLY REDUCES GETTING THE CORRECT ANSWER BY GUESSING.	1. CAN BE DIFFICULT TO GRADE UNLESS CORRECT RESPONSE IS TOTALLY UNAMBIGUOUS. 2. NOT SUITABLE FOR MEASURING COMPLEX LEARNING OUTCOMES EXCEPT FOR MATH AND SCIENCE PROBLEM SOLVING.
ESSAY	1. ONLY WAY TO DIRECTLY MEASURE SOME COMPLEX LEARNING OUTCOMES SUCH AS ORGANIZING, WRITING, etc. 2. EASY TO DEVELOP ITEMS.	1. TAKES CONSIDERABLE TIME FOR STUDENT TO RESPOND AND FOR TEACHER TO GRADE. 2. DIFFICULT TO GRADE OBJECTIVELY AND RELIABLY.
INTERPRETIVE EXERCISE	1. CAN MEASURE THE ABILITY TO INTERPRET A VARIETY OF MATERIALS. 2. CAN MEASURE COMPLEX LEARNING OUTCOMES. 3. MINIMIZES THE INFLUENCE OF IRRELEVANT FACTUAL INFORMATION.	1. DIFFICULT TO DEVELOP ITEMS. 2. HEAVY DEMAND ON READING SKILLS.

MULTIPLE-CHOICE ITEM TERMINOLOGY

MULTIPLE-CHOICE TEST ITEM: A test question in which a number of alternative response options are given from which the correct answer is selected.

ITEM: A single multiple-choice question, including the choices.

ITEM SET: Two or more test items based on a common passage, problem, graph, experiment, chart or other stimulus materials.

PARTS OF THE MULTIPLE-CHOICE TEST ITEM:

1. **STEM**: The initial part of the item in which the task is given - it may be a question, directions, or an incomplete statement. It may also reference a reading passage or graphic material, such as a chart, graph, form, etc.

2. **CHOICES**: All the options in a test item.

3. **KEY**: The correct answer.

4. **DISTRACTERS**: The incorrect options.

ILLUSTRATION OF A MULTIPLE-CHOICE TEST ITEM:

STEM — Which of the following was the primary purpose for which craft guilds were formed in the Middle Ages?

A. The training of new workmen.

B. The distribution of goods.

C. The social and political advancement of their members.

D. The regulation of production.

OPTIONS = CHOICES
DISTRACTERS
KEY

Guidelines for Writing Multiple-Choice Items

*1. Be sure the item stem clearly formulates a problem or question; e.g., the learned student should be able to answer the question without reading the options.

2. Include as much of the item as possible in the stem, (but include in the stem only the material needed to make the problem clear and specific), and keep options as short as possible.

3. When using negatively stated item stems (e.g., NO, NOT, EXCEPT), underline and/or capitalize the negative term.

4. Use novel material in formulating problems to measure understanding or ability to apply principles and procedures. If more than one item relates to a single passage or graph/drawing, be sure that each item is independent of the others.

5. Be sure that there is one and only one correct answer or most correct answer that would be agreed to by subject matter experts.

6. Be sure wrong answer choices (distractors) are plausible and are in context with the stem. A distractor must have a justifiable reason for being used.

7. Be sure no unintentional clues to the correct answer are given. (e.g., length clues or grammatical clues).

8. Avoid using the option "none of these" or "none of the above", also "all of these" or "all of the above."

9. Use only four options (A, B, C, D). Five options (A, B, C, D, E) may be used for special purposes. The keyed or correct choices should vary from item to item.

10. Arrange options in logical order, if one exists. (e.g., numerical, alphabetical, etc.)

* Appendix C contains suggested stems for multiple choice test items that are cross-referenced with action verbs.

Guidelines for Writing Matching Items

Matching Item - A test item in which two lists of information are matched with each other.

1. Be sure the stems and options in each group or column are homogeneous and similarly stated.

2. Keep the list in each column short. (e.g., three stems matched to four options.)

3. Head each column with a descriptive label. Incorporate labels in the directions.

4. Have more options to choose from than stems.

5. All options must be plausible answers for all stems.

6. Arrange the options in a logical order if one exists.

7. Specify, in the directions, the basis for the matching and whether the options can be used more than once.

Guidelines for Writing Interpretive Exercises

Interpretive Exercise - A series of objective test items based on a common set of introductory materials; e.g., chart, graph, schematic, situational narrative, etc.

Selecting Appropriate Introductory Material

1. Select material that corresponds with competencies/ subcompetencies.

2. Select introductory material that is new to the student.

3. Select introductory material that is brief but meaningful.

4. Revise introductory material for clarity, conciseness and greater interpretive value.

Developing Objective Test Items

1. Develop test items that can only be answered by interpretation (analysis, synthesis, evaluation) of the introductory material; e.g., cannot be answered directly from the introductory material, or cannot be answered without the introductory material.

2. Develop a number of test items proportional to the amount of information given in the introductory material e.g. not too many questions for a very brief narrative nor too few questions for a lengthy narrative.

3. Observe all rules for writing objective test items.

PERFORMANCE ASSESSMENTS

Attitudinal and psychomotor skills are primarily measured by direct observation of student performance. To facilitate maximum objectivity of teacher observation, checklists and rating scales are recommended. Teachers may use either or both of these to measure attitudinal skills and psychomotor skills. If assessment of the subcompetency requires degrees of quality or levels of performance, a rating scale or score card type assessment instrument is recommended. However, if the assessment of the subcompetency requires only a right/wrong, or an acceptable/not acceptable performance, a checklist type assessment instrument is recommended.

Guidelines for Developing Performance Assessments

A. For assessments designed to measure performance of a task that does not result in a tangible product, the following questions are relevant:

1. Does the checklist/rating include all important steps?
2. Are the steps stated briefly and clearly?
3. Are the steps sequenced in order of performance?
4. If levels of performance are required, is the rating scale appropriate for each step?
5. Have the more important or critical steps been assigned more weight in determining mastery?
6. Do steps of equal importance receive the same weight in determining mastery?
7. Is the mastery criterion based on the requirements of performing the task on the job?
8. Would any two qualified raters using the checklist/rating scale score the same performance in the same way or in nearly the same way?

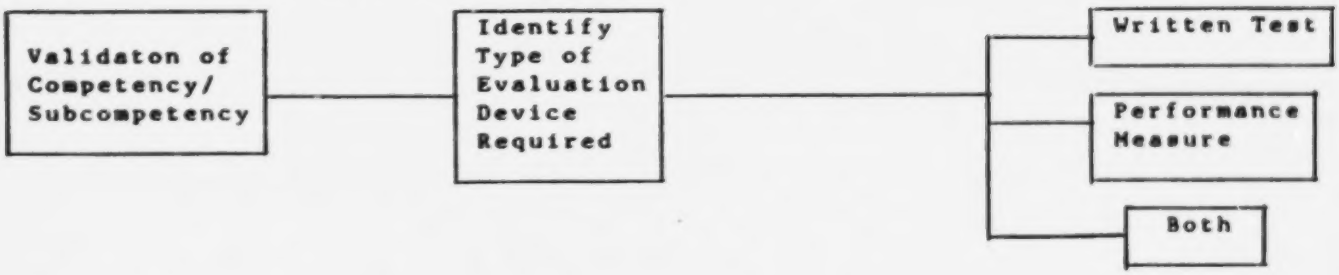
B. For assessments designed to measure performance of a task that results in a tangible product, the following questions are relevant:

1. Does the checklist/rating scale include all important parts of the product?
2. Are the parts of the product described briefly and clearly?
3. Are the parts organized on the checklist/rating scale in a way that facilitates their assessment?
4. If degrees of quality of the product are required, is the rating scale appropriate for each part of the product?
5. Have the more important or critical parts been assigned more weight in determining mastery?
6. Do the parts of the product having equal importance receive the same weight in determining mastery?
7. Is the mastery criterion based on the way the product is supposed to look, work, be repaired, etc., on the job?
8. Would any two qualified raters using the checklist/rating scale score the same product in the same way or in nearly the same way.

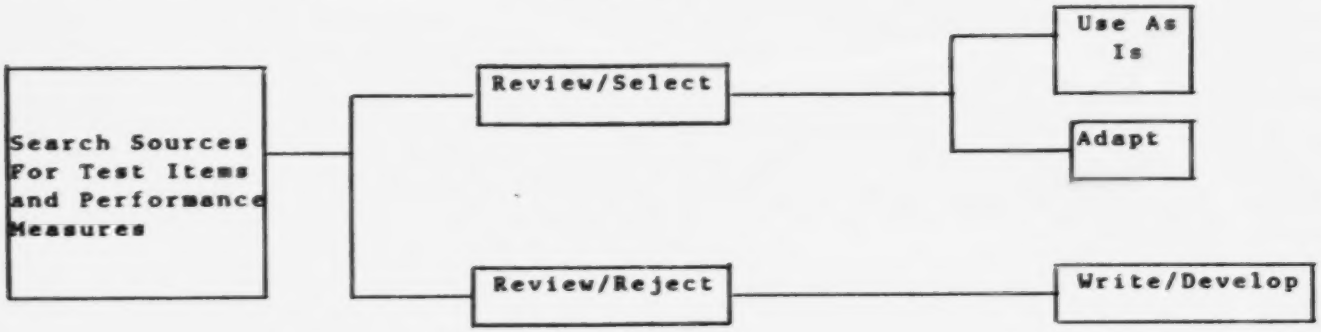
C. For assessments designed to measure both the performance of the task and the resulting product, apply the questions for both A and B to the checklist/rating scale.

DEVELOPMENT AND PRODUCTION OF TESTS AND PERFORMANCE MEASURES

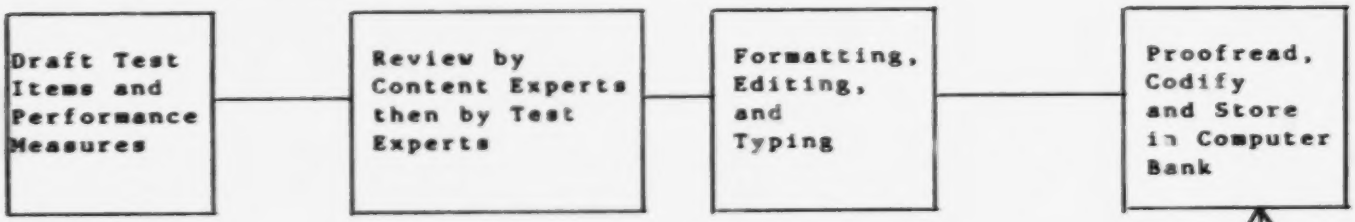
Step 1: Identify type of evaluation



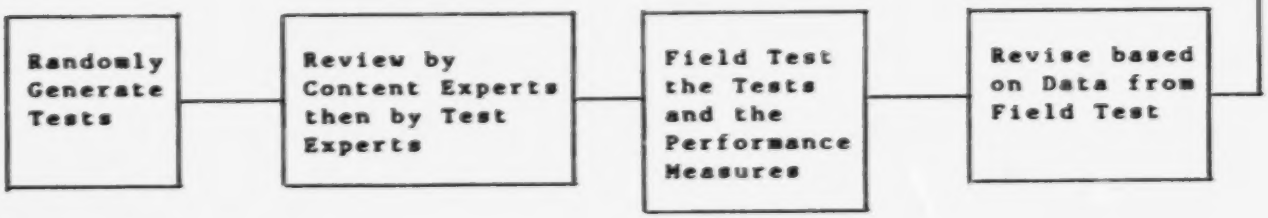
Step 2: Review and Selection Activity



Step 3: Production


Draft Test Items and Performance Measures
Review by Content Experts then by Test Experts
Formatting, Editing, and Typing
Proofread, Codify and Store in Computer Bank

Step 4: Field Trial/Revision


Randomly Generate Tests
Review by Content Experts then by Test Experts
Field Test the Tests and the Performance Measures
Revise based on Data from Field Test

STEPS TO DEVELOPING COMPETENCY REFERENCED MULTIPLE CHOICE TEST ITEMS

1. Analyze the subcompetency to be measured for learning/ assessment level, skill area, scope of content (See page 26).

2. Write the stem. (must stand alone e.g. the learned student should be able to answer without looking at the options).

3. Write the correct answer. (must be clearly the only or clearly the best.)

4. Write the distractors. (must be plausible and logical)

5. Arrange the distractors and the correct answer. (logically sequenced).

6. Review test item for correctness as per Multiple Choice Test Item Checklist. (see page 26).

STEPS FOR DEVELOPING A COMPLETE TEST ITEM BANK

1. Develop enough test items to comprehensively measure each and every subcompetency within a competency (see Table 1 for minimum number of items on page 27).

2. Be sure that each test item is coded for computer entry on Form AT 100 (See page 28).

   Example:

   Course Number H R I 1 2 0

   Competency # 0 1 Subcompetency A

   Level 1 (2) 3 Skill Area (A) B C

   Item # 1 - 0 Borrowed Item: yes (no)

   Supportive Document: F i g. # 0 1

3. Proceed to the next competency and repeat steps one and two for all competencies and their corresponding subcompetencies.

4. If needed, develop equivalent items for each of the subcompetency test items developed in step one.

ANALYZING A SUBCOMPETENCY

1. Compare the subcompetency with its corresponding competency and related subcompetencies. Use these comparisons to clarify the scope of the instructional intent of the subcompetency.

2. Determine the primary means of measuring student achievement specified by the subcompetency; e.g. performance measures or written test items.

3. If written test items are specified as the primary means of measuring student achievement, proceed with developing written test items.

4. If performance measures are specified as the primary means of measuring student achievement, proceed first with developing the performance measures (checklists, rating scales, etc.) then proceed with developing written test items that relate to those performance measures.

MULTIPLE CHOICE TEST ITEM CHECKLIST

- Stem clearly asks a question or states a problem?
- Stem stated positively or negative is underlined?
- Correct answer clearly correct?
- Distractors and correct answer approximately same length?
- Distractors plausible answers?
- Distractors parallel in context?
- Correct answer and distractors logically sequenced?
- Item grammar and punctuation correct?
- Item free from unintended clues?

TABLE 1

Table 1 shows the relationship between the total number of subcompetencies in a course, and the minimum number of test items needed per subcompetency for the course; e.g., by multiplying the total number of subcompetencies times the number of test items per subcompetency, the results will approximate a minimum number of items needed for the course. The number of test items per subcompetency may be made up of only original test items or original test items and equivalent test items.

Original test items are all of those items necessary to comprehensively measure the content scope of a subcompetency. A subcompetency that is very narrow in scope may require very few original items, but a subcompetency that is very broad in scope may require many original items. If the number of original test items does not equal or exceed the minimum number of items required, equivalent items will need to be developed in order to build a test item bank.

An equivalent test item must measure the same content as its respective original item but should be worded in a significantly different way. The number of original items plus the number of equivalent items must equal or exceed the minimum number of test items required per subcompetency.

SUBCOMPETENCY/TEST ITEM CHART

Minimum Number of Test Items Per Subcompetency

25	20	19	18	17	16	15	15	14	14	14	14	13	13	13	13	13	13	12	12	12	12	12	12	12	12	12	12	12	11	11	11	11
4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

Total Number of Course Subcompetencies

MULTIPLE-CHOICE TEST ITEM FORM

COURSE NUMBER __ __ __ __ __ __

COMPETENCY # __ __ SUBCOMPETENCY ___

LEVEL 1 2 3 SKILL AREA A B C

ITEM # __ - __ BORROWED ITEM: yes no

*SUPPORTIVE DOCUMENT: Fig. # __ __

CORRECT ANSWER: A B C D E

STEM: _____

_____

_____

_____

_____

_____

A. _____

_____

B. _____

_____

C. _____

_____

D. _____

_____

E. _____

_____

* Supportive document (graph, schematic, narrative) on back of sheet.

Form AT 100

APPENDIX B

GLOSSARY OF OPERATIONAL DEFINITIONS

OF

ACTION VERBS

Align/ Calibrate - a psychomotor skill where the student must function at the application level by making adjustments according to specified procedures and standards which must be primarily evaluated by direct observation of the alignment/calibration process and results.

Analyze - an intellectual skill where the student must function at the problem-solving level by ascertaining the nature and relationship of the parts when dividing a complex whole into its component parts which must be primarily evaluated by the accuracy of the results of the analysis and/or the effectiveness of the analysis schema(s).

Arrange/Sort- an intellectual skill where the student must function at the information level by ordering or grouping information or materials according to given criteria which must be primarily evaluated by the accuracy of the arranged/sorted information or materials.

Assess - an intellectual skill where the student must function at the problem-solving level by evaluating a process, object, or condition with respect to worth or significance which must be primarily evaluated by the accuracy of the assessment.

Calculate - an intellectual skill where the student must function at the application level by finding an unknown value using rule(s) of mathematics which must be primarily evaluated by the accuracy of the calculation.

Cite - an intellectual skill where the student must function at the information level by retrieving factual information which must be primarily evaluated by the accuracy of the cited information.

Classify - an intellectual skill where the student must function at the application level by assigning information/material according to predetermined categories which must be primarily evaluated by the accuracy of the categorical assignment.

Compare/ Contrast - an intellectual skill where the student must function at the application level be examining for similarity or divergency according to predetermined criteria which must be primarily evaluated by the accuracy of the comparison/contrast.

Construct/ Fabricate - a psychomotor skill where the student must function at the problem-solving level by building, forming, shaping, or molding a product that has been at least partially self-conceived or self-modified which must be primarily evaluated by direct observation of the construction/fabrication and the quality of the product.

Convert - an intellectual skill where the student must function at the application level by changing information from one classification system to another using specified conversion procedures which must be primarily evaluated by the accuracy of the conversion.

Define - an intellectual skill where the student must function at the application level by specifying conceptual information as it is used according to its essential characteristics which must be primarily evaluated by the accuracy of the definition.

Design - an intellectual skill where the student must function at the problem-solving level by conceiving a plan, product, or device to resolve a problem or need which must be primarily evaluated by the functionality of the results of the design.

Determine - an intellectual skill where the student must function at the application level by recognizing solutions and/or alternatives according to predetermined criteria which must be primarily evaluated by the accuracy of determined solutions or alternatives.

Develop - an intellectual skill where the student must function at the problem-solving level by devising and producing a product, plan, or procedure to resolve a problem or need which must be primarily evaluated by the functionality of the developed product.

Diagnose/ Troubleshoot- an intellectual skill where the student must function at the problem-solving level by drawing a conclusion regarding a malfunction or illness which must be primarily evaluated by the accuracy of the conclusion.

Exemplify/ Emulate - an attitudinal skill where the student must function at the problem-solving level by striving to equal or excel a model which must be primarily evaluated by direct observation of the emulation/ exemplification.

Explain/ Describe - an intellectual skill where the student must function at the application level by clarifying, concepts, principles, rules, procedures, and observations according to their functional characteristics which must be primarily evaluated by the accuracy of the explanation/description.

Follow - an attitudinal skill where the student must function at the application level by following a set of procedures which must be primarily evaluated by direct observation of the following.

Identify/ Select - an intellectual skill where the student must function at the information level by recognizing objects, symbols, conditions, and situations according to predetermined criteria which must be primarily evaluated by the accuracy of the identification/selection.

Implement - an intellectual skill where the student must function at the application level by putting into effect ideas, plans, or procedures according to set guidelines which must be primarily evaluated by the accuracy of implementation.

Initiate - an attitudinal skill where the student must function at the problem-solving level by engaging in safe/professional behavior without prompting which must be primarily evaluated by direct observation of the behavior.

Inspect - an intellectual skill where the student must function at the application level by checking or testing against established specifications which must be primarily evaluated by the accuracy of the results of the inspection.

Install/ Assemble - a psychomotor skill where the student must function at the application level by assembling or setting up equipment/components/systems according to specified directions which must be primarily evaluated by direct observation of the installation/assembly.

Interpret - an intellectual skill where the student must function at the application level by discerning the meaning of displayed data/information according to specified criteria which must be primarily evaluated by the accuracy of the interpretation.

List - an intellectual skill where the student must function at the information level by retrieving and writing a list of information which must be primarily evaluated by the accuracy of the listing.

Locate - an intellectual skill where the student must function at the information level by indicating place or site according to specified limits which must be primarily evaluated by the accuracy of location.

Manage - an intellectual skill where the student must function at the problem-solving level by executing and/or directing a plan of action which must be primarily evaluated by the execution of the plan and the functional results of the management.

Manipulate - a psychomotor skill where the student must function at the application level by moving or treating with the hands or by mechanical means according to specified directions which must be primarily evaluated by direct observation of manipulation.

Measure - a psychomotor skill where the student must function at the application level by ascertaining physical characteristics based on recognized standards which must be primarily evaluated by direct observation of the measurement.

Modify - an intellectual skill where the student must function at the problem-solving level by making an alteration to an existing object, process, or situation which must be primarily evaluated by the functionality of the modification.

Operate - a psychomotor skill where the student must function at the problem-solving level by executing the function(s) of equipment or systems to produce desired results which must be primarily evaluated by direct observation of the operator.

Opt/Choose - an attitudinal skill where the student must function at the problem-solving level by making a decision that specifies a course of action in a job related situation which must be primarily evaluated by direct observation of the option/ choice.

Perform - a psychomotor skill where the student must function at the application level by carrying out a set of prescribed procedures which must be primarily measured by direct observation of the performance.

Prepare - a psychomotor skill where the student must function at the application level by making ready for use according to set procedures which must be primarily evaluated by direct observation of the preparation.

Record - an intellectual skill where the student must function at the application level by writing down information according to set guidelines which must be primarily evaluated by the accuracy of the recorded information.

Relate - an intellectual skill where the student must function at the application level by specifying an association between two or more items according to predetermined characteristics which must be primarily evaluated by the accuracy of the association.

Repair - a psychomotor skill where the student must function at the problem-solving level by correcting (fixing or replacing) a malfunction which must be primarily evaluated by direct observation of the corrective action and the quality of the repair.

Service - a psychomotor skill where the student must function at the problem-solving level by providing and conducting equipment and/or systems maintenance which must be primarily evaluated by direct observation of the maintenance.

Solve - an intellectual skill where the student must function at the application level by finding the solution to a given situation using prescribed rules and techniques which must be primarily evaluated by the accuracy of solution.

State/Name - an intellectual skill where the student must function at the information level by retrieving or expressing information in words/names which must be primarily evaluated by the accuracy of the stated/named information.

Transcribe/Translate - an intellectual skill where the student must function at the application level by transferring information from one form to another following prescribed guidelines which must be primarily evaluated by the accuracy of the transcription/translation.

APPENDIX C

SAMPLE STEMS FOR MULTIPLE CHOICE TEST ITEMS

RELATED TO SPECIFIC ACTION VERBS

LIST STATE/NAME CITE	Which one of the following would (would not) be found on a list of _____? Which one of the following is another name for _____?
IDENTIFY/SELECT LOCATE ARRANGE/SORT	From the symbols in Figure 1, select/identify/ locate the one that is used when _____? Which one of the following would (would not) belong in an arrangement of _____?
CLASSIFY EXPLAIN/DESCRIBE RELATE COMPARE/CONTRAST DEFINE	Which one of the following statements best explains/describes the application of _____? Which one of the following is (is not) a common characteristic of _____ and _____ and _____? (_____) is to (one principle), as (_____) is to (_____) The effect of _____ is mostly like which one of the following? Which one of the following statements best describes the relationship between _____ and _____? Which one of the following statements is (is not) a true meaning of _____? The definition of _____ implies which one of the following statements?

	Refer to Fig. 1 and solve/calculate for the _____.
	Given the following conditions, determine the steps involved in finding the _____.
CALCULATE SOLVE	Given _____, convert to _____.
DETERMINE CONVERT INSPECT	Which one of the following techniques is needed (NOT needed) when inspecting for _____.
INTERPRET RECORD IMPLEMENT	In the following recorded information, which item(s) is (is NOT) accurately recorded?
TRANSCRIBE/TRANSLATE	Which one of the following is (is NOT) an example of the implementation of the second step of the _____ procedure?
	Refer to Figure 1, and translate/transcribe the information in block A3.
	From the schematic (drawing) in Figure 1, find the _____.
FOLLOW	While performing _____ procedure, a practitioner omits _____. Which one of the following statements best describes the action of the practitioner?
	Refer to Figure 1. While assembling/installing a _____, an installation technician reads the instructions in Fig. 1. Which one of the following is the correct action to be taken by the technician?
MANIPULATE PREPARE	Refer to Figure 1 and determine the reading on the meter.
INSTALL/ASSEMBLE ALIGN/CALIBRATE MEASURE	The preparation of _____ requires all of the following steps EXCEPT _____.
PERFORM	While performing the duties of a _____, the following situation was encountered. What action should be taken?
	During alignment/calibration of _____, the following measurements were recorded: Which one of the following statements is true regarding the next action to be taken?

	In the design/development of a _____, the following was selected: Which one of the following statements is the most logical reason for the selection? (or) Which one of the following statements is the most logical reason why the selection was NOT correct?
	Refer to Figure 1. An assessment of the situation described in Figure 1, would lead to the conclusion best described in which one of the following statements?
DEVELOP/DESIGN ANALYZE ASSESS MANAGE MODIFY DIAGNOSE/TROUBLESHOOT	Refer to Fig. 1. In order to modify the situation/drawing/model/plan in Figure 1 to comply with _____, which one of the following should be done?
	Refer to Figure 1. While in charge of _____, a practical nurse encounters the situation described in Figure 1. Which one of the following actions should be taken?
	Given a list of the characteristics regarding _____, which one of the following statements would be (would NOT be) found on the list?
	While troubleshooting/diagnosing a _____, the following facts were recorded: Which of the following could be the problem?
	Refer to Figure 1 and determine the status of component Z when component X is on and component Y is off?
	Refer to Fig. 1 and choose the statement which best evaluates the action taken by the _____.
INITIATE EXEMPLIFY/EMULATE OPT/CHOOSE	Given the situation described in Fig. 1, which of the following actions should the professional _____ take?
	While servicing a piece of equipment, the following readings were observed. Which of the following adjustments should be made?
SERVICE OPERATE REPAIR CONSTRUCT/FABRICATE	During operation of _____, the following situation occurs: Which of the follwing actions should the operator take?
	Refer to Fig. 1 and determine which one of the following repair procedures would correct the fault?
	Which of the following characteristics would be most important when constructing/fabrication a/an _____?

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